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EMISSIVITY AND TEMPERATURE SCALE FOR VACUUM HEATED URANIUM

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By H. B. Wahlin

In this investigation the true and apparent temperatures were determined for uranium which had been heated in a vacuum of 10^{-6} mm or lower for a period of 300 hours or more.

The procedure was to take flat strips of the metal and roll them into hollow cylinders about 3 mm in diameter and 12 cm long. A hole 1/2 mm in diameter was drilled in the side of the cylinders. These were then mounted in a tube connected to a pumping system and evacuated. During the heat treatment continuous pumping was carried on.

At the start the emissivity, calculated from the temperatures of the metal surface and the temperature of the hole (which gives the true temperature), was higher than the final value. Continuous heating at temperatures between 1250 and 1300°K will clean the surface and lower the emissivity. This cleaning, it seems, may be speeded up by turning the heating current off and allowing the cylinder to cool through the recalescence points.

The emissivity (E) was calculated from the equation

$$\ln E = \frac{14384}{.6705} \left(\frac{1}{T_T} - \frac{1}{T_a} \right)$$

where T_T is the true and T_a is the apparent temperature, .6705 is the mean wavelength transmitted by the red glass used in the eyepiece of the optical pyrometer.

As will be seen from the accompanying plot of emissivity against true temperature, there is a sudden change in emissivity between the temperatures 1321 and 1323°K. The cause of this change is unknown although it may be a third crystal structure change. Such a change in emissivity with crystal structure has been observed in iron.

The question naturally arises as to whether the metal surface is free of oxide after prolonged heat treatment. While this cannot be answered definitely from the data, it seems that an oxide surface will give a much higher emissivity. The value of .453 observed below 1321°K is lower than the .46 obtained for clean tungsten.

The optical pyrometer readings were taken by Dr. Frances Johnson and Miss Monica Bainter, both instructors in the Department of Physics at the University of Wisconsin. Both observers were found to have excellent "pyrometer eyes."

Below are listed the true and apparent temperatures calculated from the emissivity data above. It must be emphasized, however, that this temperature scale is only applicable to clean uranium surfaces.

True temperature	Apparent temperature	True temperature	Apparent temperature
1180	1130.7	1290	1231.4
1190	1139.9	1300	1240.5
1200	1149.1	1310	1249.6
1210	1158.3	1320	1258.7
1220	1167.4	1325	1256.7
1230	1176.6	1330	1261.2
1240	1185.7	1340	1270.2
1250	1194.9	1350	1279.2
1260	1204.0	1360	1288.2
1270	1213.1	1370	1297.1 (?)
1280	1222.2		

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